stationary barometer, when an important area of high pressure is central over the Southern States.

9. That "the tidal waves," falsely so called, especially for Lake Erie, are due to large and rapid changes in atmospheric pressure such as are noticeable upon the barograph preceding or during thunderstorm conditions.

10. That the larger lake undulations may account for the existence of the greater waves encountered by fishermen and often termed the "three sisters."

The author adds that similar results to these for the lakes have been obtained by him from the study of the tidal records at St. John, N. B., and Halifax, N. S., and he is quite enthusiastic as to the useful results that may be attained in weather forecasting when such tidal records on the lakes and on the western seaboard are submitted to careful study.

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Mr. Denison had the kindness to bring to the Weather Bureau samples of his interesting and valuable records, but after some consideration of the subject the Editor was forced to the conclusion that his large scale barograph curve will of itself be more useful in the study of and prediction of the weather than the record of the lake levels, which latter is full of fluctuations due to seiches and shorter waves and has no very close relation to the barograph or to the curve of air pressure. The study of the seiche is an important matter in the study of lake levels and engineering projects, but does not seem to be especially essential to meteorology.

## HISTORIC DROUGHTS IN THE UNITED STATES.

From two well-known volumes (Peirce, "On the Weather," Philadelphia, 1847, page 272, and Perley, "Historic Storms," Salem, 1891, pages 58 and 66) we learn something about two of the severest droughts on record. The meteorologist will find it an interesting problem to explain, even in a general way, the reasons for these great departures from normal conditions.

1749. The spring was uncommonly dry, and by the end of May pastures were all scorched and burned in eastern Massachusetts. The drought probably continued longer and was felt more severely than any one that the people had before experienced. June 9 was appointed as a day of public fasting and prayer. Between July 1 and 6 plenty of showers fell in New England, and the period of drought was brought to an end. A small crop of hay, barley, and oats and a good crop of indian corn were harvested; flax and herbs of all kinds were a failure; cattle were killed in the autumn to save the great expense of keeping them through the winter.

1762. There was scarcely any rain from April 9 to August 18, and in some places, as at Danvers, until September 22. The month of April was cold. There was a slight drizzling rain at Boston May 7 and June 3 and showers on June 18. July 7 a fast was held at Falmouth, Me., and at Milton, Mass. July 28, being fearful that a famine would ensue, a public fast was proclaimed in a number of cities. Refreshing showers occurred near Falmouth, but not elsewhere until August 18, when bounteous rain descended throughout New England. Crops were, of course, very light and cattle were generally slaughtered because of the difficulty of keeping them through the winter.

1816. This summer, which is known as the cold one, was also a very dry one in many regions. In Vermont no rain fell during May and very little in Connecticut. During June intense heats were followed by freezing weather, with snow squalls in several of the New England States. The snowfall on the 8th of June in Vermont amounted in some places to 12 and 18 inches. In July there was abundant rain in northwestern Massachusetts and New Hampshire; from that time a drought continued until October 22, having prevailed for one hundred and twenty days in Vermont. Owing to the cold and the drought the crops were an almost complete failure.

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Our scanty records make it quite impossible to present a really satisfactory summary of the meteorological conditions that prevailed during these historic droughts, but it is sufficiently evident that any locality between Pennsylvania and Maine may count upon having an absolute drought of three months' duration at least once in a century and injurious droughts of a month's duration very much more frequently. It is by no means impossible for the farmer to secure admirable crops during such droughty seasons if he will make proper provision for artificial irrigation. It is much more business-like to profit by past experience and provide artesian wells, windmill water pumps, protected reservoirs, and irrigating ditches than to neglect all these and spend one's time in praying for rain. Fast days and prayers were all right for the early settlers of the country, before they knew the exact nature of our climate, but now that three hundred years of records have accumulated and we know or ought to know how to succeed in the struggle against the inexorable laws of nature, it behooves us to profit by our experience. New England farmers have been very slow to realize the profit that is to be drawn from a parched soil and a cloudless sunny sky by the simple means of irrigation. Methods of cultivation that have made the desert spots of central Asia, Algeria, northern India, Australia, and California profitable gardens have until lately been ignored in New England.

## INTERNATIONAL BALLOON ASCENSIONS, JUNE 8, 1898.

The fifth series of international simultaneous balloon ascensions came off on the morning of June 8, with great success. The following brief summary is condensed from the full account that is published in Ciel et Terre, July 1, Vol. XIX, p. 203.

Owing to the interest in the subject, stimulated by the conference at Strasburg (see MONTHLY WEATHER REVIEW, November, 1896, pp. 365, 415, and 462, and April, 1898, p. 158), six nations, Austria, Belgium, Italy, France, Germany, and Russia took part in this most important meteorological campaign. The Daily Weather Map for Europe shows that on the morning of June 8 the isobar of 765 mm. covered central Europe with a very irregular curve, and that a pressure as low as 760 could only be found by going far to the west and south. Consequently, the most gentle barometric gradients prevailed throughout the region represented by the balloon ascensions, and very slight changes in pressure and temperature occurred during the twenty-four hours. Light rains had fallen on the immediate coast of the North Sea during the night before, and were again repeated during the following night, but the interior of the country was everywhere clear or partly cloudy, with rare cases of local thunderstorms. The morning temperatures ranged from 12° to 16°, the maximum temperatures 16° to 25° C., over this part of Europe. The operations at each station were as follows:

*Vienna.*—One sounding balloon and three ordinary military balloons, manned by officers of the army, were sent up successively at 6, 7, 8 a. m., and the last one at noon. The latter reached an altitude of 4,500 meters, where the temperature was —8° C.

*Berlin.*—Four balloons started, respectively, at 6 a. m., 9 a. m., and noon, and the last at 2 a. m. the next morning. Of course the winds near the ground were light and baffling, but the balloons moved slowly toward either west-northwest or west-southwest, according to their altitudes.

*Paris.*—The sky was so foggy in the morning that the sounding balloon could not be observed at the theodolite sta-

tions, and the ascension was, therefore, delayed. One balloon started at 10:05 a. m. from Paris, and descended at 4 p. m. in Westphalia, having attained a height of from 14,000 to 16,000 meters, where the temperature was —64° C.

*Paris.*—The great sounding balloon of 465 cubic meters capacity was sent up from Paris by the French Aerostatic Committee and carried a self-registering actinometer of Violle's construction. This actinometer registered perfectly. It furnishes a continuous clear line upon which we see depicted all the events of the ascension; the departure in cloudy weather, the passage through the clouds, the attainment of the highest point in less than three-quarters of an hour, then a very slow descent during several hours, finally the very rapid descent that brought the balloon to the ground after a sojourn of eight hours in the atmosphere. During the whole of the highest horizontal soaring the black bulb of the actinometer had a constant temperature of —12° C., or about 50° above that of the surrounding air. This actinograph record has apparently given results that are not entirely accordant with current ideas on the subject; it shows that actinometry by means of these atmospheric soundings will give us a better knowledge of solar radiation and atmospheric absorption.

The automatic photographic apparatus of Cailletet, for determining the altitudes, recorded the pressures in an excellent manner, but owing to the cloudiness could not give a direct measurement of altitude.

*Trappes near Paris.*—Three sounding balloons adjusted to explore different layers in the atmosphere were sent up from the meteorological observatory of M. Teisserenc de Bort. The first started at 3:03 a. m., attained 12,500 meters, with a temperature of —60° C., and was carried by the upper cirrus current toward north 35° east. The second started at 4:55 a. m., attained 9,000 meters, with a temperature of —42°, and traveled northward. The third started at 7:55 a. m., attained 6,800 meters and a temperature of —21°, and traveled toward the north-northwest. The lowest wind blew from the east-southeast, so that the successive upper currents were steadily deflected from this direction toward the right up to the highest, which moved toward the north 35° east.

*Strasburg.*—A sounding balloon and a manned balloon, as well as a balloon-kite, were used. The latter remained up during twenty-four consecutive hours. The sounding balloon started at 8:30 a. m., moved easterly, attained an elevation of 11,000 meters and a temperature of —50° C.

*Brussels.*—An ordinary balloon ascended to 1,500 meters.

*Berlin.*—The balloon manned by Berson started at 2:38 a. m. and descended at 4:15 a. m. During this one hour and thirty-seven minutes, it traveled 160 km. and attained an altitude of 5,500 meters. The balloon manned by Suring attained about 5,300. The balloons manned by Captain Gross and Lieutenant Siegsfeld, respectively, attained about 4,500 meters. Berson found a temperature of —12° C. at 5,500, while Siegsfeld found —8° at 4,500 meters. But, of course, these preliminary results will be changed by subsequent comparison of thermographs. In all manned balloons the temperatures have been observed by means of Assman's ventilated thermometer.

Of the seven sounding balloons, five had been heard from when the report was written. One of the French sounding balloons carried, for the first time, an actinometer, and also Cailletet's photographic altitude apparatus (see the MONTHLY WEATHER REVIEW for October, 1897, p. 443).

Aerophile No. 3, leaving Paris at 2:30 a. m., fell into the hands of some kind-hearted but ignorant persons, who thought that the blackened surface of the cylinder on which the record was registered had been unfortunately blacked by smoke, imagining that the balloon was a *montgolfière* or hot-air balloon, and that the aeronaut had been killed by the combustion of the balloon. They, therefore, thought that they were doing a kindness to clean up the cylinder and polish off the thin layer of lampblack. When Teisserenc de Bort arrived to claim his priceless record, he found the cylinder shining like new, but with no trace of the delicate lines that the stylus had traced when high up in the ethereal blue. However, the kind people gave the aeronaut a charming reception.

Something similar happened to the Parisian balloon that descended in Westphalia. These incidents show that the popular daily journals have not as yet explained the theory of the sounding balloon with sufficient fullness. They show furthermore that Moedebeck, of Vienna, did well to attach to his sounding balloon a strip of cloth a meter broad and six meters long, on which he painted the proper notice in large letters in German, French, Russian, Magyar, and Turkish.

## THE SMITHSONIAN WEATHER PREDICTIONS.

An interesting contribution to the history of weather telegraphy in the United States and the development of our knowledge of American meteorology is published on pp. 271–275 of the Proceedings of the American Academy of Arts and Sciences, Vol. IV, for the years 1857–1860. On August 9, 1859, Prof. Joseph Henry, Secretary of the Smithsonian Institution, addressed the Academy on the above subject; probably the published account is generally expressed in his precise words, but there is evidence that it was prepared, at least, in part by the recording secretary of the Academy, Samuel L. Abbot, or by the publication committee whose chairman was Prof. Joseph Lovering, a well-known authority in magnetism and meteorology. The following is a copy of the published record and any additional facts will be gratefully acknowledged by the Editor.

Professor Henry, of the Smithsonian Institution, made a verbal communication relative to the application of the telegraph to the prediction of changes of the weather, particularly in the city of Boston and its vicinity.

It has been fully established by the observations which have been made under the direction of the Smithsonian Institution, and from other sources of information, that the principal disturbances of the atmosphere are not of a local character, but commence in certain regions, and are propagated in definite directions over the whole surface of the United States east of the Rocky Mountains.

From a careful study of all the phenomena of the winds of the temperate zones, it is inferred that over the whole surface of the United States and Canada there are two great currents of air continually flowing eastward. These currents consist of an upper and a lower, the former returning the air to the south which was carried by the latter towards the north. The lower current, which is continually flowing over the surface of the United States, is about 2 miles in depth, and moves from the southwest to northeast. The upper or return current, which is probably of nearly equal magnitude, flows from northwest to southeast, or nearly at right angles to the other, and the resultant of the two is a current almost directly from the west. The reaction of these two currents appears to be the principal cause of the sudden changes of weather in our latitude. They give definite direction to our storms, accordingly as the latter are more influenced by the motion of the one or the other of these great aerial streams. The principal American storms may, from our present knowledge, be divided into two classes; namely, those which have their origin in the Caribbean Sea, and those which enter our territory from the north, at the eastern base of the Rocky Mountains. Those of the first class, which have been studied with much success by the lamented Redfield and others, follow the general direction of the Gulf Stream and, overlapping the eastern portion of the United States, give rise to those violent commotions of the atmosphere which are in many instances so destructive to life and property along our eastern coast. These storms from the south are frequently two or three days in traversing the distance from Key West to Cape Race, and their approach and progress might generally be announced by telegraph in time to guard against their disastrous effects. Though the general direction of these storms appears to be made out with considerable certainty, much remains to be done in settling the theory of their character and formation.

The materials which have been collected at the Smithsonian Institution during the last seven years relative to the other class of storms have enabled us to establish general facts of much value not only in a scientific point of view but also in their application to the prediction of the weather. (This statement was verified by a series of maps ex-